THE ENGINEER.

The British Industries Fair at Birmingham.

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THE British Industries Fair opens on Monday, February 18th, under what appear to us to be the best auspices it has ever experienced. A preliminary investigation has assured us of the satisfactory nature of the arrangements which have been made for the display of the exhibits of the Birmingham section of the Fair, where the majority of those appliances of interest to our readers will be congregated; we understand, also, that the section of the Fair which is held at the "White City" in London will merit the attention of engineers, despite the fact that, at first sight, the exhibits may appear to be mainly of a non-technical nature. In this Supplement, however, we concentrate on those exhibits which are to be shown at Castle Bromwich, Birmingham. But before describing them we must reiterate that plea which we have put forward before—that a wealthy centre like Birmingham ought to have a more central exhibition site than that offered by the old aerodrome at Castle Bromwich, which can only be reached after a tedious journey by rail or road from the centre of the city. However, the Birmingham Chamber of Commerce has made the best of the facilities offered, and this year the arrangements are far more convenient than they have ever been before. The buildings have been extended so that they cover an area of half a million square feet of flooring, and since the old corridors have been eliminated and all cross walls thrown down, there is an unimpeded vista from end to end. For this reason several familiar stands have been pushed bodily sidewards, with the object of maintaining a straight alignment; but there is no very drastic change in their location. The result of the new arrangement is that the exhibitors can be catalogued in rows, from A to N, and in blocks, from 1 to 20, without any reference to individual buildings, with obvious convenience of the visitors. An innovation is the addition of some unroofed exhibits, such as agricultural implements and contractors' machinery which are normally operated in the open air. Let us hope that the elements will be kind to these exhibitors.

In the present Supplement, which is accompanied by a two-page plate, we deal with many of the exhibits. We shall devote a similar Supplement, in our next issue, to the Fair.

PETTERS, LTD.

The largest engine on the stand of Petters, Ltd., of Westland Works, Yeovil, will be the single-cylinder 62·5 B.H.P. engine, shown in Fig. 1. This unit will be in operation, and it is representative of the improved "C" type series of heavy-oil engines which are built in various sizes up to 600 B.H.P. The engine shown has a bore of 14in. with a stroke of 16in., and is designed to develop its full output of 62·5 B.H.P. at 275 r.p.m. One of the main features of the type is the completely water-cooled cylinder head, which is provided with a readily detachable jacket, thereby giving easy access to the water-cooling spaces for purposes of cleaning, and at the same time allowing free expansion in all directions for the combustion chamber. Starting is effected by a piece of circular lamp wick, housed in a special holder, which wick, when smouldering, provides the amount of additional heat necessary to start the engine from cold. The maximum cylinder pressure is about 400 lb. per square inch, and immediately after starting, the combustion is maintained by the heat of compression at all ranges of load. At the opposite end of the engine to the fly-wheel, the bed-plate is extended to accommodate the fuel injection pump and governor. Very close governing is obtained by means of the by-pass valve on the fuel pump, which is governor controlled. The governor is of the high-speed centrifugal pattern, and it is furnished with a hand-operated speed regulator, allowing a speed range of 20 per cent. to be effected while the engine is running.

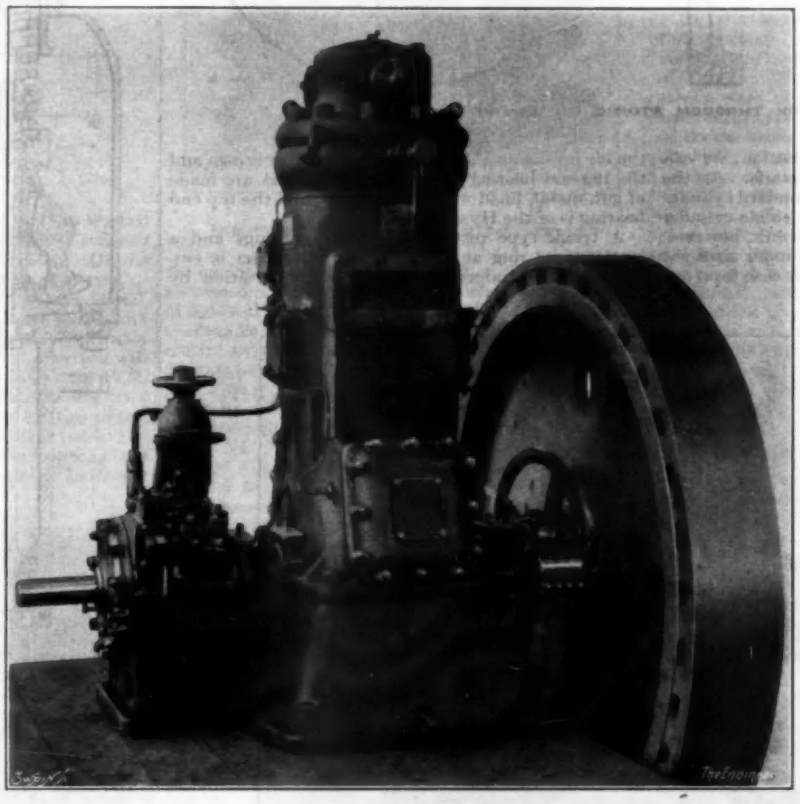


FIG. 1—62·5 H.P. HEAVY OIL ENGINE—PETTER

Perhaps the most interesting engine on this stand will be the new high-pressure airless injection motor, which is shown for the first time, and is known by the name of the "Atomic Diesel" engine. The word "Atomic" refers, of course, to the atomising of the fuel, and it has been registered as the trade-mark by the makers. It is well known that experimental work has been going on at Yeovil for several years past in the direction of producing an engine which, while possessing the high efficiency of the Diesel engine, is not complicated by the valves, compressors, &c., which are associated with Diesel engines of the air injection type. The engine now referred to is the direct outcome of these experiments, and before placing the design on the market the makers have subjected it to prolonged and severe tests in their own power-house at Westland Works, where a 100 B.H.P. four-cylinder engine of this type has been utilised for generator driving. By adopting the firm's improved two-stroke cycle, along with crank case compression and the airless injection of the fuel, the parts of the engine have been reduced to comparatively few, giving a cylinder cover of a symmetrical shape. The test results, as may be gathered from the fuel consumption graph—see Fig. 5—show a high efficiency which does not fall off, we are informed, after long periods of running.

A general view of the engine is reproduced in Fig. 3, and in the drawing, Figs. 2 and 4, two cross sections, together with details of the atomiser, fuel pump, and centrifugal governor, are given. The engine exhibited is the smallest unit in a range of two series, each of four sizes of engine. In the first series the designed output is 25 B.H.P. per cylinder, at a speed of 400 r.p.m., and the largest unit is the four-cylinder 100 B.H.P. engine. The cylinder bore is 8in., with a stroke of 11¾in. In the second series the rated output is 40 B.H.P. per cylinder, giving powers up to 160 B.H.P.

The new engine is also particularly well suited for marine use on account of its compact form and small dimensions, and marine engines of this type are now being designed and built.

From the two sections of the engine reproduced in Fig. 2, the working cycle may be conveniently followed. On the upward stroke of the piston air is drawn through the automatic inlet plates on the sides of the crank case. On the downward stroke of the piston the air in the crank case is compressed to a pressure of approximately 4 lb. per square in. When near the bottom of its stroke, the piston uncovers the scavenge ports in the sides of the cylinder wall, the lightly compressed air in the crank case rushes into the cylinder, and is directed towards the top of the combustion chamber, and thence downward again, thus effecting an efficient scavenge of the exhaust products. The charge of fresh air in the cylinder is compressed on the upward stroke of the piston to a pressure of 450 lb. to 500 lb. per square inch. It will be noted that the top of the piston is in the form of a truncated cone, and the cylinder head is shaped accordingly, there being very small clearance allowed between the two when the piston is at the top of the stroke. The combustion chamber itself is connected with the main cylinder by a restricted passage, and during the last portion of the upward stroke, the highly compressed air is forced into the upper combustion chamber with considerable force. It is this action which causes the comparatively high degree of turbulence on which the efficient combustion of the engine depends. Slightly before the top dead centre is reached, a charge of oil is injected through the fuel atomiser in the centre of the top of the combustion chamber and directed downwards in a fan-shaped spray, the finely divided particles penetrating the turbulent air and an intimate mixture is effected. The temperature brought about by the compression is sufficient to cause ignition, and rapid combustion follows without shock. On nearing the bottom of its stroke, the piston uncovers the exhaust ports, whence the inert gases are

allowed to escape to the silencer. This exhaust action takes place slightly in advance of the opening of the scavenge ports on the opposite side of the cylinder, following which a fresh charge of air enters and the cycle is thus completed. An indicator diagram we have inspected shows the form typical of the air-injection engine.

shape of U-shaped leathers, which are supported by rings with the two sides kept apart by helical circumferential springs resting in the trough of the leathers. It may be noted from Fig. 2 that the air inlet plate valves on either side of the crank case communicate with the underside of the lower crank case casting. This arrangement assists in silencing

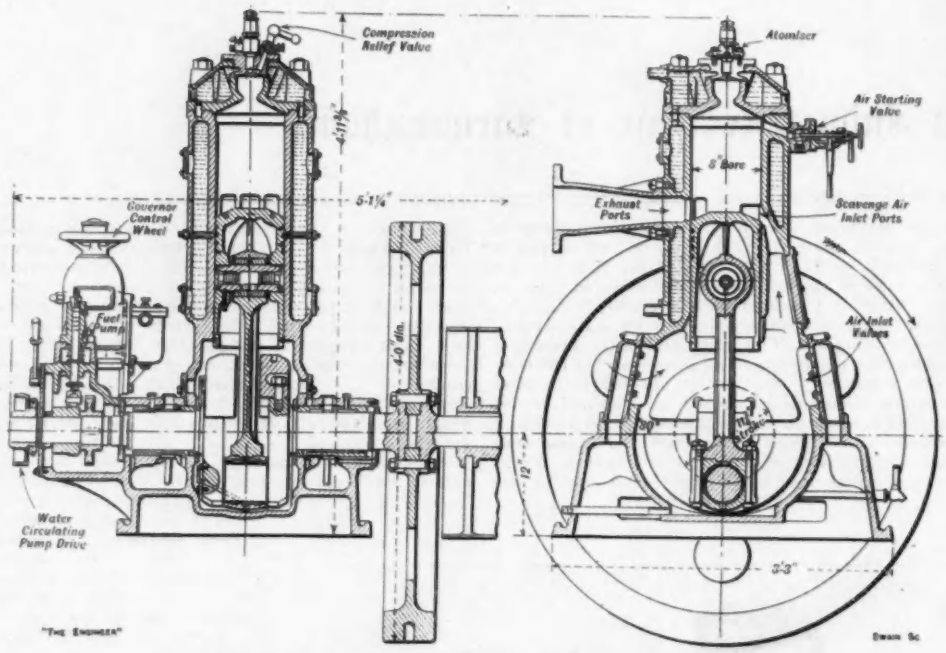


FIG. 2—SECTION THROUGH ATOMIC OIL ENGINE—PETTER

Having dealt with the cycle of operation, we can now proceed to the constructional details. As the multi-cylinder engines are built up of standard cylinder units, it will suffice to describe the single-cylinder unit which we illustrate. We may remark, however, that whereas in the 25 B.H.P. per cylinder sizes the cylinder and the upper half of the crank case form one

the air intake on the engine. The main bearings and the big-end bearing on the connecting-rod are made of gun-metal, lined with white metal, and the top end bearing is of the Hyatt roller type.

A trunk type piston with four top rings and a single wiper ring at the bottom of the skirt is employed. The gudgeon pin is locked in position by

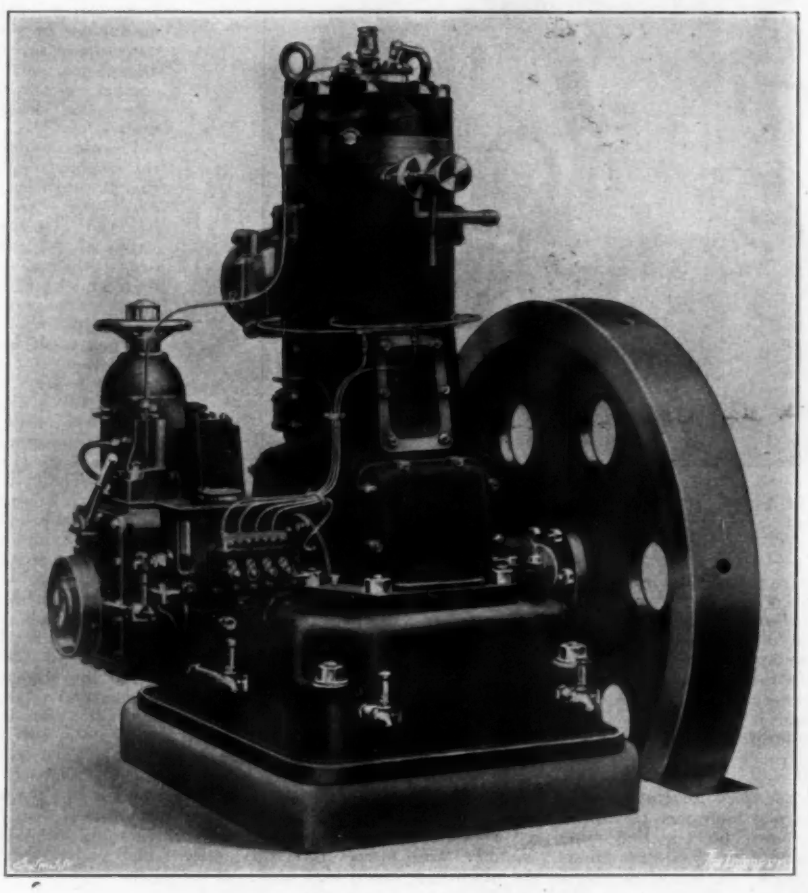


FIG. 3—ATOMIC OIL ENGINE—PETTER

casting, in the 40 B.H.P. per cylinder units the crank case and the cylinder are two separate castings. In the multi-cylinder engines a fuel pump is fitted for each cylinder, each pump being furnished with a cut-out. In the case of the larger engines an outboard bearing is provided for the crank shaft.

The crank shaft is made as a single forging, and the sealing rings for the crank case take the

a set screw, and is provided with brass wipers at the ends, which are kept in contact with the cylinder walls by spring pressure. The oil picked up by these wipers serves to lubricate the small end bearings.

Attention may be drawn to the symmetrical cylinder cover with the centrally placed atomiser. At the side of the atomiser is the compressor relief valve, which

is in the form of a plug, provided with an interrupted thread that can be locked in position like a breech screw and instantly withdrawn by a partial turn. When running, this plug is locked in position by a thumb screw.

In Fig. 4 we show a section through the atomiser. A steel atomiser nozzle is fitted to the end of the atomiser body, and forms the seating for the needle valve, which is held in position by a spring. Provision is made for adjusting the pressure exerted by this spring. On the fuel inlet connection a simple form of a release valve is provided, and the fuel flows into an annular chamber surrounding the needle valve casing. From this chamber it reaches the nozzle by way of slits cut in the needle valve body, and, under pump pressure, the oil is sprayed into the cylinder through five holes drilled radially in the nozzle. Injection continues until the spill valve comes into operation, when it instantly ceases.

In Fig. 2 a section through the fuel pump is also given. The plunger is operated by a tappet through the medium of a rocker lever, with a roller engaging with the fuel cam. This cam is adjustable on its shaft, which forms an extension of the engine crank shaft. A hand priming lever is fitted at the end of the fuel pump and governor casing, which moves the

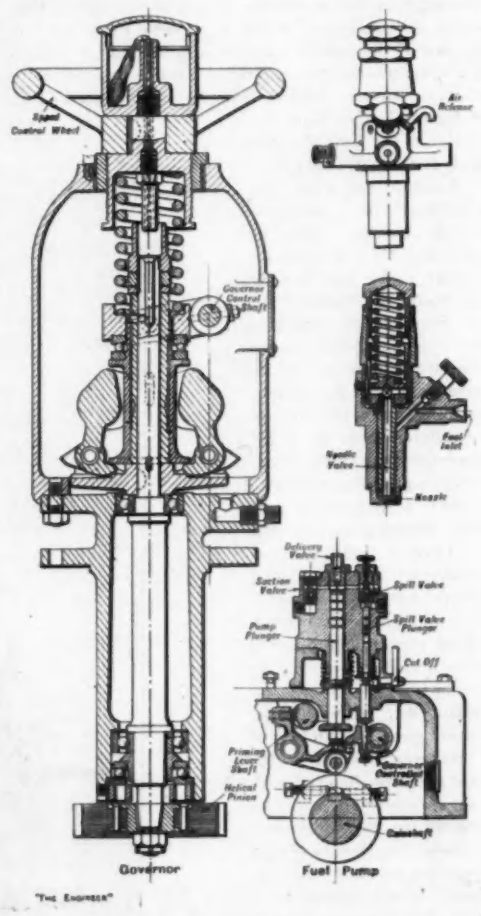


FIG. 4

priming lever shaft. The shaft has a cam-shaped section, and when turned it lifts the fuel pump plunger through the rocker lever. The rocker lever has an adjusting screw at its top end, and at its lower end hardened pads are fitted, where it engages with the fuel plunger tappet and the projection on the governor controlled tappet lever, which operates the spill valve plunger. The tappet lever under the spill valve plunger is mounted excentrically on a shaft, which is connected by links and rods to the governor. It receives its motion from the fuel plunger rocker lever, but the amount of lift is varied by the position of the governor-controlled shaft and the setting of the adjusting screw. There is a small clearance between the top of the spill valve plunger and its ball valve, so that the main fuel pump plunger travels a certain part of its stroke before the spill valve comes into action, and by-passes the remainder of the oil, which otherwise would have passed to the atomiser. Means are provided for setting the spill valve plunger by the adjusting screw immediately below its tappet. In order to cut-off the fuel entirely. A small cut-off lever is provided to the right of the spill valve plunger, with an excentric cam. By turning this handle the whole of the fuel delivered by the plunger is by-passed, and this, in a multi-cylinder engine, affords a ready means of isolating the fuel supply on any given cylinder. In Fig. 4 we also show a section through the vertical centrifugal type governor, which is driven from the crank shaft by helical gearing. The weights and all revolving parts are enclosed in an oil-tight casing, at the top of which there is mounted the hand wheel for controlling the speed of the engine.

At the top of the governor casing is a syphon oil cup for the lubrication of all the governor parts. The movement derived from the rise and fall of the governor weights is transmitted to the fuel pump shaft through a transverse shaft in the governor casing, and from thence by means of rods and links to the fuel pump spill valve control shaft.

The single-cylinder engine which we illustrate is provided with a hand-operated air-starting valve, incorporating a hand lever and a locking device, which enable the engine to "charge back" into the air receiver bottles. In the case of the multi-cylinder sets mechanically operated air-starting valves

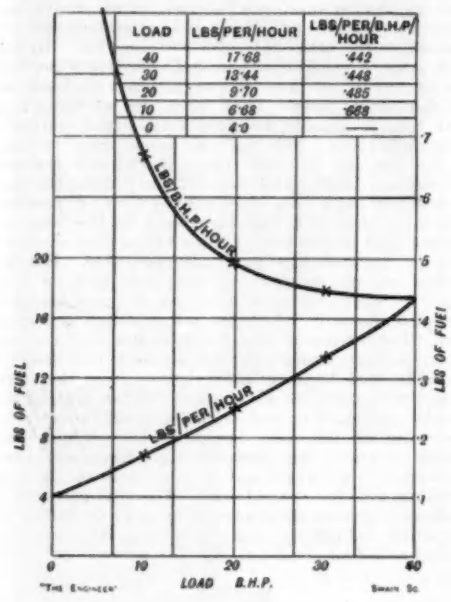


FIG. 5

are arranged at the end of the engine, and are worked from a cam on the crank shaft, which gives a timed delivery of starting air to all the cylinders. On the cylinders themselves non-return valves are fitted.

With regard to the lubrication of the Atomic Diesel, this, as far as the cylinder liner, gudgeon and crank pin bearings, is dealt with by a mechanical lubricator of the Calibrater type, a full description of which will be found in THE ENGINEER for December 9th, 1927. There are four separate feeds for each cylinder, two each to the liner and piston and one for the piston pin and the crank pin bearings. The oil is fed to the piston pin from either end. The main bearings are ring lubricated, and a gauge glass indicator

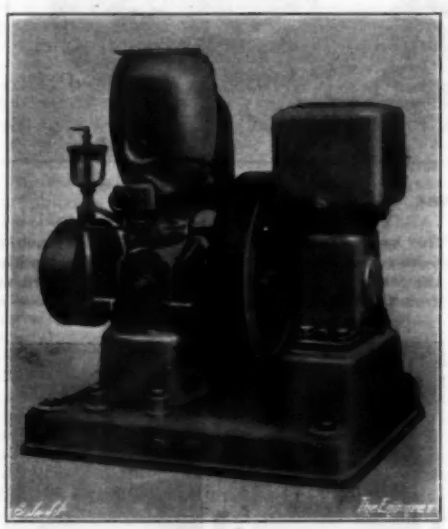


FIG. 6—COMPRESSING SET—PETTER-REAVELL

is fitted to show the level of oil in the sump. The whole of the fuel injection and control valve mechanism is contained in an oil-tight casing, and the level in the sump is indicated by gauge glasses fitted with drain cocks, which will be seen in Fig. 3 on the front and side of the engine. As will be seen from the engine sections, water jackets of ample size are provided, and in the case of the cylinder heads, particular care has been taken to insure good cooling. For the larger sized cylinder engines the water jacket for the cylinder head is made as a separate unit to facilitate withdrawal for cleaning purposes. The water pump is belt driven from a small pulley fixed at the end of the crank shaft.

Some test figures for a 40 B.H.P. single-cylinder engine, together with the consumptions at different loads, are indicated in Fig. 5. If the fuel consumption of 0·44 lb. per B.H.P. hour at full load be taken with a fuel oil of 18,500 B.Th.U.'s per pound the thermal efficiency of the engine works out to 31·3 per cent. The consumption at fractional loads can be derived from the curves given in the figure.

Among the other engines on Petter's stand we may single out for particular mention the small air compressor set shown in Fig. 6. It consists of a 1½ B.H.P. hopper cooled engine with magneto ignition, coupled directly to a self-contained air compressor of the Reavell type. The plant is designed to compress up to pressures of 300 lb. per square inch, and runs at about 700 revolutions per minute. In addition to a 1½ kW electric lighting plant, one of the firm's new Auto-Petter-Light plants, of 700 watts capacity, will be shown. A view of this set is shown in Fig. 7, and a description of it was given in THE ENGINEER of December 14th, 1928. The main feature is the automatic control of the plant from a switch which may be placed anywhere in the house. The speed of

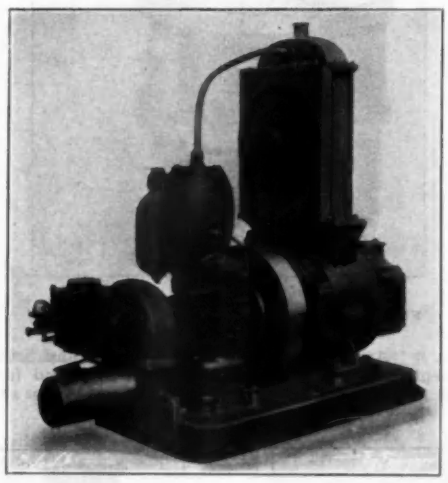


FIG. 7—700 WATT LIGHTING SET—PETTER

the engine is controlled by a governor, which regulates the consumption of petrol in proportion to the number of lights in use. The engine is of the 1½ B.H.P. type, running at 750 r.p.m., and the set is designed to light either twenty-three 30-watt lamps or thirty-five 20-watt lamps at 110 volts pressure. These automatic plants are made in three sizes of 700, 950 and 1450 watts capacity, and other voltages.

Other engines to be exhibited include examples of the new "NL" marine type of engine, described in our issue of August 24th last, when we dealt with a four-cylinder 36 B.H.P. unit installed in a ferry boat for Egyptian service. The engine to be exhibited is a two-cylinder model of 18 B.H.P.

R. A. LISTER AND CO., LTD.

The stand of R. A. Lister and Co., Ltd., Dursley, Gloucestershire, will be occupied by a series of petrol engines ranging in output from 1½ H.P. up to 10 H.P. together with some electric lighting sets of both the fully automatic and the switchboard types. There will be a deep-well pump and some pumps for lifts up to 25ft.; but the outstanding feature, among this firm's exhibits, will be a service of passenger-carrying trucks, one of which we illustrate in Fig. 8, for conveying visitors from end to end of the Fair building.

This passenger-carrying truck is somewhat similar to the commercial trucks shown on the Lister stand, and is driven by a 600 cc., 4½ H.P., J.A.P. petrol engine, which is cooled by the ordinary fan system. From the engine the drive is taken by a chain to a multiple disc clutch, and thence, again, by another chain to the front driving wheel. It will be noticed that the framing of the chassis is specially set up at the rear, so that carrying wheels as large as 17in. in diameter can be accommodated, while there is room for a spring suspension of the rear axle. The vehicle is intended to carry a load of 1 ton, and to surmount a gradient of 1 in 14 when fully loaded, while it is said to be capable of running 20 miles on 1 gallon of petrol. As arranged for the Fair purposes, it has accommodation for twelve passengers.

On the stand there will also be several other developments of much the same idea, including a mechanical sweeper and sprinkler and an auto-truck. This latter machine, which is equipped with a 4½ horse-power petrol engine and a four-speed gear-box, is capable of drawing a load of 23 tons on the level at a speed of 5 miles per hour.

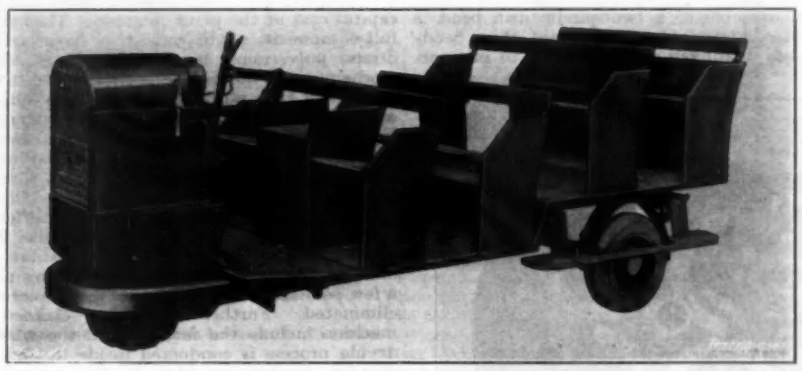


FIG. 8—PASSENGER CARRYING TRUCK—LISTER

THE MIDLAND FAN COMPANY, LTD.

The portable paint-spraying plant manufactured by the Midland Fan Company, Ltd., of 212, Aston-road, Birmingham, is suitable for all types of paling and girder work painting, particularly outside work. The drive can be arranged either electrically, as shown in Fig. IX., to suit any current, or the machine may be equipped with a petrol engine, so as to be available anywhere. It has an air-cooled air compressor, 3½in. in diameter by 4in. stroke, fitted with a fast and loose pulley and striking gear. The cylinder is easily removable, and the valve is a simple plate carefully ground to fit the cylinder end. It is easily accessible. Phosphor bronze bearings are fitted to the big end and drip feed lubrication is provided for the cylinder. The whole plant is mounted on a substantial truck, and is really a portable plant. The sprayer pistol supplied with these machines is very simple in design, effective in use, and appears to be comfortable to handle.

MARSHALL, SONS AND CO., LTD.

ON the stand of Marshall, Sons and Co., Ltd., Gainsborough, there will be several engines of the vertical and horizontal types, one of which is illustrated in Fig. I. There will be two examples of the two-stroke class of engine, one of 16 B.H.P. and of the horizontal type, with the hot bulb system of ignition, while the other will be a 60 H.P. vertical engine. In the latter set crank case compression is utilised for the scavenging air, and the fuel oil is injected on the "solid" principle by means of a pump. Primary ignition is effected by means of an electrically heated plug, and the engine is controlled by a horizontal governor driven directly off the crank shaft. The two four-stroke engines on this stand will be of 30 B.H.P. and of 25 B.H.P. respectively. It is claimed for these engines that they have a fuel consumption of half a pound, or less, per horse-power per hour. They are fitted with ring oiling bearings, and have the fuel pump and governor gear all running in oil baths. There will also be a concrete mixer fitted with ball bearings on this stand.

WINGET, LTD.

The most novel exhibit on the stand of Winget, Ltd., Grosvenor-gardens, Westminster, will be the brick breaker illustrated in Fig. X. It is much after the fashion of the orthodox stone breaker, and is built principally of semi-steel castings, while the jaws are of manganese steel. The toggle which operates the jaw is, however, of cast iron, and is of such dimensions and design that should some foreign substance, such as a bolt, be accidently dropped into the crusher the toggle will collapse and prevent more serious damage to the machine. The block against which the toggle abuts is adjustable to determine the size of the crushed product, and this adjustment can be made while the crusher is running. The side cheeks are provided with a peculiar locking device, which prevents any movement of the fixed jaw, while crushing is proceeding. These machines are made in three different sizes, with jaws ranging from 8in. by 5in. to 12in. by 6in. On the same stand there will also be examples of the maker's concrete mixers, stone crushers and concrete block-making machines. Concerning the concrete mixers, it is hardly necessary here to enlarge, as we have dealt with them before in connection with exhibits of contractors' machinery, while the stone breakers are of the single toggle type, but are noteworthy in that they are generally

associated with a rotary screen, so supported that it will work freely, even if it is erected with the outboard bearing somewhat out of line. The concrete block machines exhibited will be of both the plate-tamp type and of the usual form for making hollow or solid building blocks.

Alfred Herbert, Ltd.

Among a number of small tools, gauges, chucks, and similar exhibits to be shown by A. Herbert, Ltd., of Coventry, we notice various sizes of two-speed and four-speed drill heads of the type illustrated in Figs. 9, 13 and 14. These heads are designed to provide a ready and efficient means of converting an ordinary single-spindle drilling or boring machine into a high production multi-spindle drilling and tapping machine.

The four-spindle drill head shown in Fig. 9 is intended for drilling equidistant bolt and other holes lying on a variable pitch circle. The concentric adjustment of the four spindles is obtained, as shown in Fig. 12, by means of an annular gear ring meshing with gear wheels on which the spindle bearings are mounted excentrically. All the spindles are therefore adjusted simultaneously, and always remain concentric. The diameter of the pitch circle to which they are set is indicated by graduations on the outside of the drill head. Once set, the spindles can be locked in position so far as the pitch circle diameter is concerned. Each spindle has an individual vertical adjustment in order that wear of the drills may be compensated. An indexing sleeve and locking latch is provided on the head shown in Fig. 9, whereby the drills may be set into various stations, so as to permit two, three, or four times as many holes to be drilled as there are spindles. The drill head may be used in conjunction with a jig plate, the bushes in which are provided with the same form of concentric adjustment as the drill spindles. The transmission of the drive to the four spindles of the drill head shown in Fig. 9 is effected by means of universal joints. In other designs made by Alfred Herbert, the transmission is effected by means of gear wheels, a plan which increases rigidity and economises space. An example of a two-spindle drill head is shown in Figs. 13 and 14. If required, these heads may be made with fixed spindle centres to suit particular work. Other forms of multi-drill heads made by the firm include one in which the drills are set out on a straight line, the distance between them being either independently adjustable or adjustable automatically to any desired uniform pitch.

Another exhibit on Alfred Herbert's stand is a

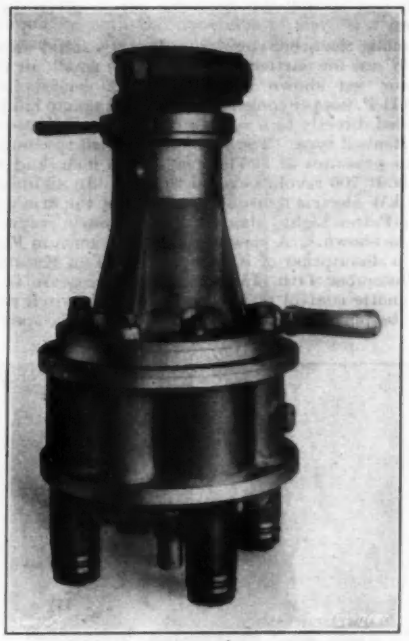
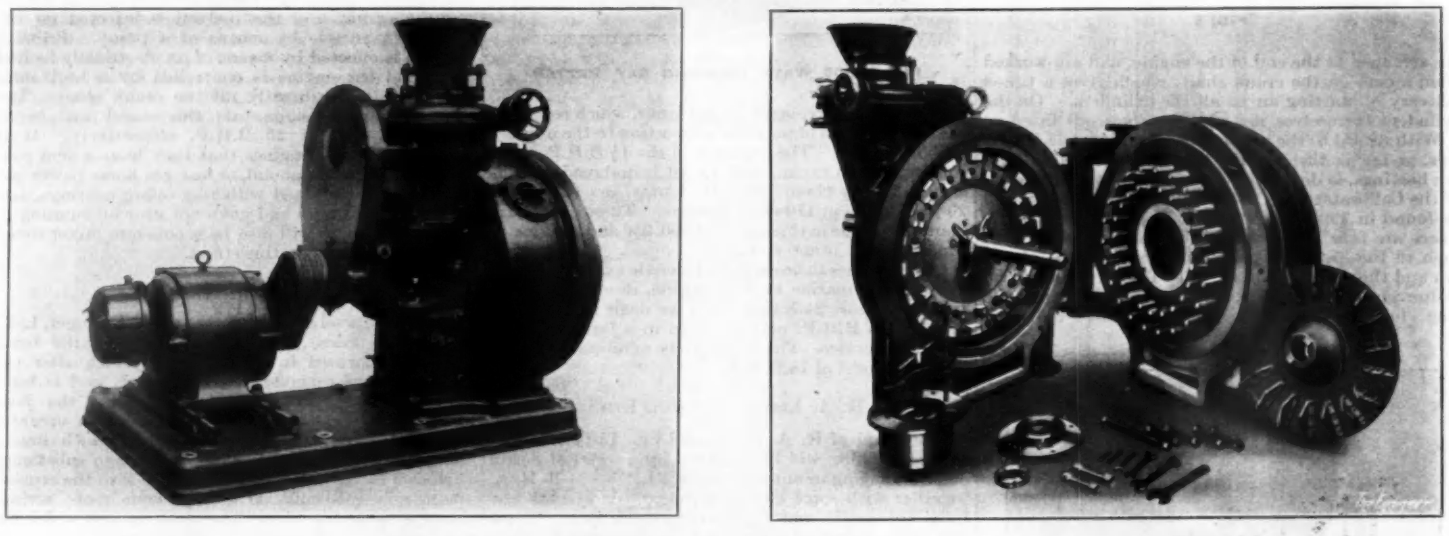


Fig. 9—4 Spindle Drill Head—Herbert

No. 6 "Atritor" coal-drying, pulverising and firing machine. Until recently, the use of powdered fuel has in not a few instances been handicapped by the capital cost of the plant required. That plant, in a full equipment, might consist of elevators, hoppers, driers, pulverisers, storage bins, fans, and feeder. mechanism for the burners. In addition, the storage of the fuel after pulverisation has been found to present difficulties, because of its hygroscopic nature and because of the risk of spontaneous combustion. The "Atritor" machine is a self-contained unit which dries, pulverises and blows the fuel directly into the furnace. It does not require any anxiliary equipment beyond an elevator and a bunker for the raw coal. As its use does not involve the storage of powdered fuel, and since at any instant the total amount of coal inside the machines does not exceed a few pounds, all risks of spontaneous combustion are eliminated. Further advantages claimed for the machine include the fact that as the whole of the drying process is conducted inside it, and not as a separate preliminary step in the process, all the volatiles in the coal pass with it into the furnace, and are not, in part, lost. It is, in addition, claimed that the running costs are very low, the power required per ton of pulverised fuel being about 15 kWh in the case of a machine dealing with bituminous coal and having a capacity of 2000 lb. per hour or over. The machine, it is also pointed out, is dustless and noiseless in operation.

The coal, limited in size to ¾in. cubes, is fed into the hopper of the machine and falls on to a horizontal rotating disc. A sleeve, adjustable for height, controls the spreading of the coal over the disc and a knife, the position of which can be altered by means of a hand wheel, scrapes the coal off the disc and regulates its feed to the machine. This feeding system is claimed to give a fine regulation of the coal, and to avoid all possibility of the fuel becoming jammed. From the feeder the coal descends to the separator whereby all portions of metal or other foreign substances heavier than coal are rejected before the pulverising stage is reached. The separation is effected by a current of cold air, which is indicated in Fig. 15, enters the machine in such a way and at such a point as to deflect the descending stream of coal upwards. The velocity of the air is, however, not sufficient to sustain any portions of metal, stone, &c., present in the coal. Such bodies are not deflected, and descend down a chute from which they are discharged.

The stream of coal passing on, enters the pulverising section at or near its axial centre. Pulverisation takes place in two stages, one on one side and the second on the other side of a rotating disc. In the first stage a number of hammers are freely pivoted on the hub of the disc. These hammers are held out by centrifugal force. They catch the incoming coal and beat it against a screen ring, which partially surrounds them. The coal now passes over the edge of the rotating disc and moves downwards towards its centre. During this stage of the process the fuel is reduced to a fine powder by means of beaters, which, as shown in Fig. 11, consist of two rings of square pegs on the face of the rotating disc, and two rings of circular pegs on a stationary disc. Hot air passes into the machine with the coal, and not only dries it, but takes an active part in promoting the completeness with which the pulverisation is carried out. The air-borne coal forms eddies and vortices in its passage through the second stage and receives an additional degree of pulverisation from the attrition of the coal-laden air streams. Before leaving the second stage, the coal passes through a rejector, revolving at the same speed as the central disc, which separates any particles that have not been sufficiently pulverised and returns them to the pulverising zone for re-treatment. The coal particles of sufficient fineness are drawn off by a fan on the rotating shaft behind the stationary disc, and are projected as a dust cloud into the furnace.



Figs. 10 and 11—Atritor Coal Pulverising Machine—Herbert

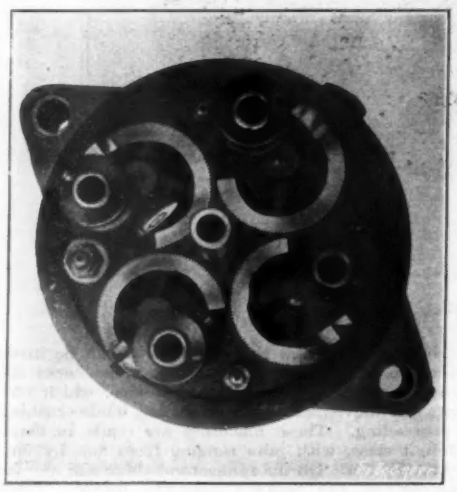
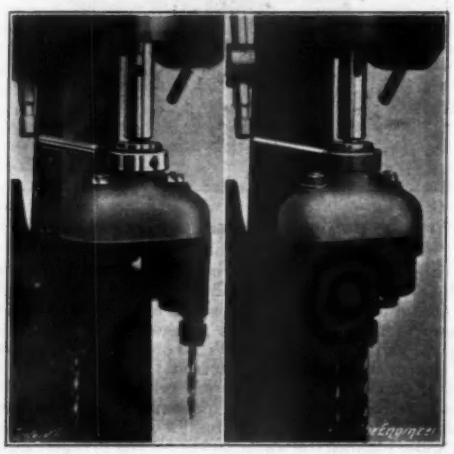


Fig. 12—Adjusting Gear of 4-Spindle Drill Head—Herbert

The supply of hot air required for the machine may be obtained, in the case of boilers, from cavities in the walls of the combustion chamber or from air heaters placed in the furnace flues. In the case of metallurgical furnaces, it may be obtained from secondary air ducts or from the recuperators with which such furnaces are usually fitted, while for rotary cement kilns, the hot air can usually be obtained



Figs. 13 and 14—Drilling Head—Herbert

from the clinker cooler. All the wearing parts of the machine are inexpensive, and the interior can be rendered accessible in a few minutes. In Fig. 10 we illustrate a motor-driven "Atritor." The actual machine to be shown at the Fair is of the same size, but is belt driven. The No 6 machine is the smallest of the range made by the firm. It is capable of pulverising 500 lb. of coal per hour. It is driven by

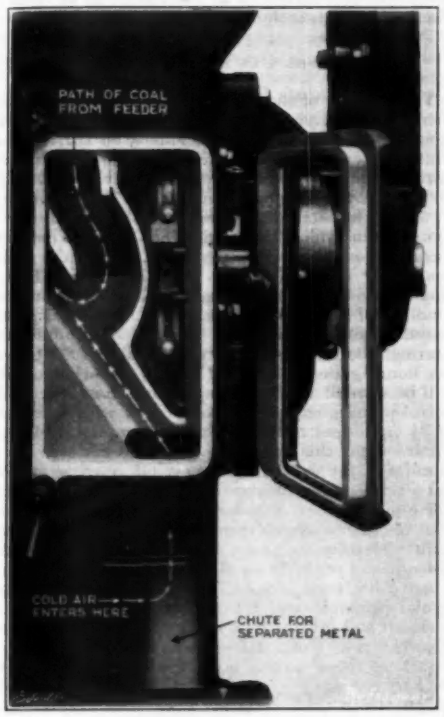


FIG. 15—ATRITOR METAL SEPARATOR—HERBERT

an 8 horse-power motor and runs at 1700 r.p.m. In the largest size the output is 10,000 lb. of pulverised coal per hour, and at that output about 90 H.P. is absorbed in the drive.

BROOKES (OLDBURY), LTD.

It is noteworthy in connection with this stand that Messrs. Brookes have recently absorbed the business interests of the Regent-street Metal Machine Tool Company, Ltd., of Wakefield, and of Messrs. Arnold and Large, of Birmingham, so that the range of tools and machines to be exhibited by this firm has been considerably enlarged.

Among these machines there is the guillotine set of shears illustrated in Fig. VII., which is of the under-crank type. That is to say, the whole of the driving mechanism is arranged below the working level, and practically the only moving part above that height is the knife itself. There are, however, a set of spring-operated holding-down devices on the machine in question for securing the plate while it is being cut. The whole of the gearing on this guillotine is machine cut, the connecting-rods are of wrought steel, with gun-metal bushes, and the countershaft runs in gun-metal bushes. The drive for the cutting knife is transmitted through a clutch of the roller key type, and is so devised that the knife stops automatically at the top of its stroke regardless of whether or not the operator removes his foot from the treadle. In other words, the machine will only make one cycle of operation, regardless of the attendant's vigilance. The machine to be exhibited is capable of cutting plates up to 4ft. wide by ¼in. thick. On this stand there will also be some exhibits of flat link chain, specially devised for use on draw benches having working tensile strengths of from 22 tons up to 140 tons. There will also be some cutting-off machines fitted with chucks for accommodating such a wide variety of diameters as from 1in. up to 2¼in., while sizes up to 3¾in. can be gripped with only one change of jaws. The chuck is so arranged that it can be opened and closed while the machine is running, and is efficiently protected against the ingress of swarf or dirt.

BULL MOTORS, LTD.

On the stand of Bull Motors, Ltd., there will be a comprehensive range of electrical machinery. Besides standard direct and alternating-current motors, some of which are to be shown in motion, there will be several special machines. The high-tension motor generator set, which was a special feature on the last occasion, will again be exhibited. The machine was developed for ship's wireless, and is to be shown in operation with the high-tension end delivering 1 kW at 2400 volts direct current, the load being utilised for illuminating a sign. An exhibit of particular interest and importance will be a special motor-driven high-frequency alternator. This set is typical of a number which have been supplied to the British Post Office and leading wireless telegraph companies, the alternator giving a single-phase output of 2 kVA at 450 cycles. A motor generator set, consisting of a standard squirrel-cage induction motor direct coupled to a standard shunt wound generator, is to be shown in operation at full load. The generator supplies current at 500 volts to a special series-wound motor, directly coupled to a tramway brake compressor. The series-wound machine was specially developed for this class of work, and constructed to form a single unit with the compressor.

GEORGE ELLISON.

The totally enclosed oil circuit breaker, shown in Figs. 16, 17 and 19, has been developed by George Ellison, of Birmingham, to meet the demand for a switch with high breaking capacity, a demand that has arisen in consequence of the growing resources of power supply, and consequent higher fault currents to be dealt with. As the result of many years' experience in the manufacture of circuit breakers for all industrial purposes, considerable improvements have been made in the

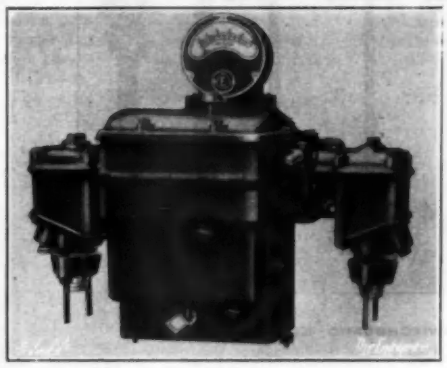


FIG. 16—TOTALLY ENCLOSED OIL CIRCUIT BREAKER—ELLISON

details of design. Oil circuit breakers of this type are suitable for controlling individual circuits and motors, and are supplied for wall or floor mounting, with mechanical interlocks in conjunction with rotor starters and other control units. The breakers can be mounted on bus-bar chambers assembled together with the usual accessories to form complete switchboards. To facilitate access to the parts and changing the trip coils, if necessary, the cast iron body of the breaker is divided horizontally, and in order to make the breaker dust and weather proof, the joint between the cover and body is packed. With the handle in the "on" position, the cover cannot be removed. Current-carrying parts are insulated from the slate base by "Tufnol" bushes and mica washers. The

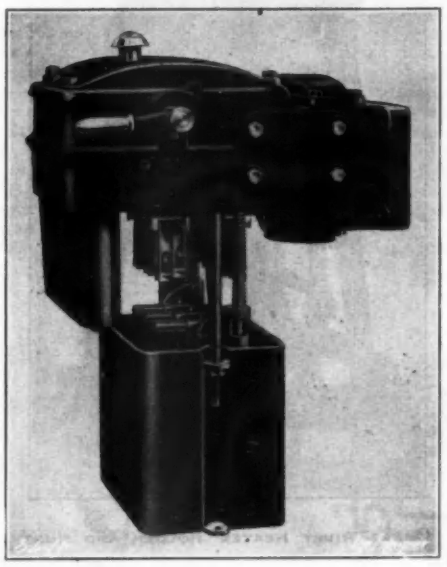


FIG. 17—BREAKER WITH OIL TANK LOWERED—ELLISON

contacts are of a novel and well-tested type, easy to overhaul and with sparking tips which can easily be renewed. The oil tank is composed of welded boiler plate with ample strength to withstand the pressure set up by interruptions of heavy currents or short circuits. Two strong steel rods, threaded at their ends to take the holding-on nuts, serve to hold the tank in position. For closing the breaker a brass lever handle is provided, whilst a push knob on the top of the cover is used to open it. The overload trip releases the free part of the closing mechanism, and prevents the breaker being held in the closed position against an overload. A switch, which opens the no-volt coil circuit, serves for tripping the breaker from a distance. Four cable aperatures are provided, one on each side and two at the back, the two not required being enclosed by bolted covers. To take cable up or down or at an angle of 45 deg., and so to accommodate cables from various directions, a cable fitting in the form of a three-part sealing box has been developed. The overload releases can be set to operate from normal full load to 200 per cent. overload, and they can be fitted with Ellison "single" or "double" time-lag devices. The no-load coil will release on gradually decreasing voltage or frequency. Six-inch dial controller pattern moving iron type ammeters can be mounted on the breaker body over the cable connection space.

Another of George Ellison's exhibits will be the totally enclosed distribution switchboard shown in Fig. 18. The cost of this type of switchboard, we understand, compares favourably with other types; in fact, it is claimed that in the long run a circuit breaker switchboard of this kind is less expensive than the more orthodox type, because the maintenance cost is almost negligible. It is also pointed out that circuit breakers are advantageous, because they enable machinery to be started up rapidly after a shut down. A breaker

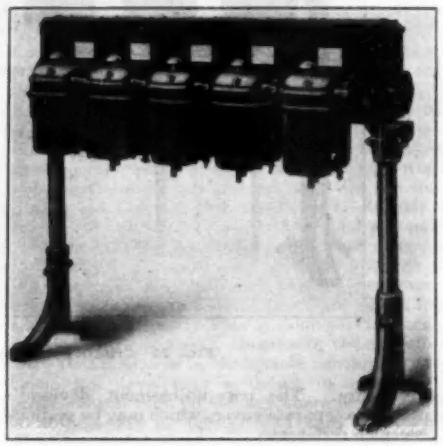


FIG. 18—DISTRIBUTION SWITCHBOARD—ELLISON

distribution board, as shown in Fig. 18, comprises a strong steel-cased bus-bar chamber supported on tubular stands with circuit breakers mounted upon it, and connected to the bus-bars, all live parts being completely enclosed. On the enclosures earthing terminals are provided, and if the earth connections are made according to the factory regulations, the switchgear may be operated by unskilled people with perfect safety. The incoming cable may be led through a sealing box or other fitting at the end of the bus-bar chamber as shown in Fig. 20. This simple type of switchgear is intended for use where interlocks and individual circuit isolators are not required, and where complete isolation can be effected at the main switchboard for occasional

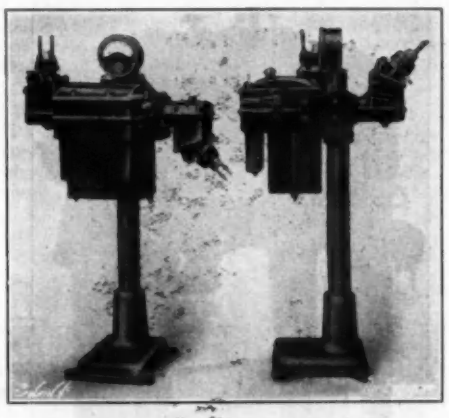


FIG. 19—CIRCUIT BREAKERS MOUNTED ON STANDS—ELLISON

inspection of the gear. If isolation at the distribution switchboard is required, the incoming cable may be taken through a unit with an interlocked isolating switch or a draw-out type unit, the multi-way bus-bar chamber being connected up to an adapter. Suitable cable fittings to connect up any class of cable that may be used for the branch circuits can be attached to the bus-bar chamber. One advantage of the circuit breaker is that it can be adjusted to interrupt the circuit automatically at any current between normal full load and 100 per cent. overload, with a time lag to retard the trip action on temporary high currents, while it permits instantaneous action on a short circuit. The No. "O" type breaker will carry 40 ampères continuously and will interrupt safely over 1500 kVA on a three-phase, 440-volt circuit, its contacts being immersed in an oil tank. This breaker is totally enclosed and can be operated by workmen without special knowledge of electrical switchgear. The closing handle is a brass lever, limited in its travel by stops, which prevent undue stress being thrown on the contacts. The lever is of the

"free-handle" type and the contacts cannot be held closed if an overload is on the circuit. The circuit is opened by pressing a brass knob on the cover of the breaker. The breaker can also be released from a distance if a no-volt coil is fitted and connected to a switch situated in any convenient position. All the breaker parts are standardised and interchangeable. The joints of the enclosure, between the top cover, body casting and oil tank, are packed to exclude dust and moisture. The trip adjustment devices are enclosed by a separate cover, which may be padlocked to prevent interference.

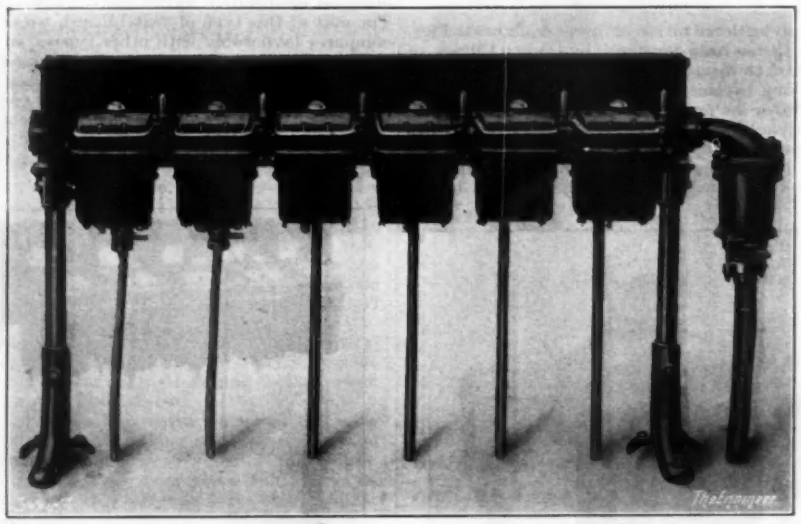


FIG. 20—CIRCUIT BREAKER SWITCHBOARD—ELLISON

HOLDEN AND HUNT.

Holden and Hunt, of Cox's-lane Works, Old Mill, Staffs., will be showing a representative collection of their electric resistance welding machines, including spot, butt, wire, and chain welders, an electric rivet heater, and an electric heater for soldering irons. All the machines will be shown in operation, and particular attention should be drawn to the new and improved 12-kW spot welder and the 4-kW wire welder. These machines embody the latest improvements that experience has shown to be desirable. A small 4-kilowatt bench rivet heater is used for heating soldering irons. An ordinary soldering iron is employed, but it is provided with a stud made of a special alloy, and it acts as a heating element. By means of this stud the soldering iron is gripped in the jaws of the

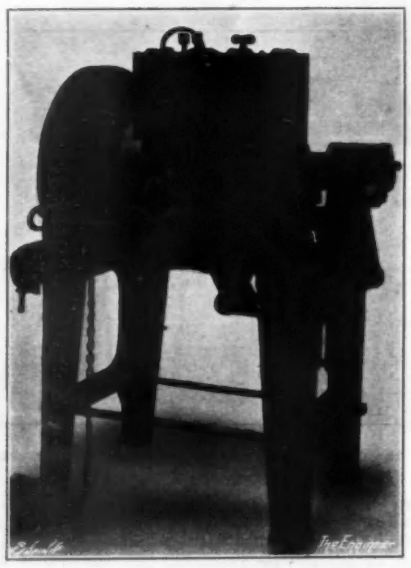


FIG. 21—CHAIN WELDER—HOLDEN AND HUNT

rivet heater, and the heat generated in the stud is absorbed by the copper bit, which rapidly attains the requisite temperature. Under working conditions it is found that a normal 1½ lb. iron heats up in from 30–60 seconds.

The principal advantages of this method of heating are that the soldering iron rarely requires re-tinning, as the heating does not destroy the tinning, the copper bit has a long life, and cost of operation is lower than that of any other method of heating, while the iron is ready for use at a minute's notice. The machine can also be used for heating small rivets.

A large size double-headed rivet heater—see Fig. 22—has several unique features. The machine has a capacity of 25 kW, and is capable of heating 220 ½in. by 3in. rivets per hour, the time for other sizes being in proportion.

The firm's universal spot welders in sizes 3 and 4 were shown last year, and on the present occasion there will be a No. 2 size machine, which has an electrical capacity of 8 kilowatts. It is capable of welding iron and mild steel up to ¼in. added thickness, or ⅜in. added thickness occasionally. The frames completely enclose the high-tension parts, while the liners are composed of high-tensile cast steel. There is said to be absolutely no risk of operators receiving shocks when the machines are in operation. All the exposed parts can be handled with impunity. An automatic trip switch with a wide range of adjustment is fitted, the renewable contacts being made of non-arcing metal. The heating speed is controlled by means of a four-way regulator. Renewable tips of varying shapes, to meet different requirements, can be quickly fitted to the water-cooled electrodes.

An example of hand-operated butt welding machine is also to be shown. This welder is intended primarily

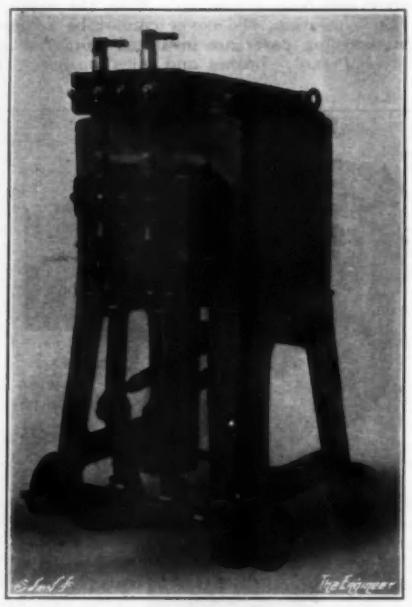


FIG. 22—RIVET HEATER—HOLDEN AND HUNT

for heavy jobbing work, and is capable of welding up to 1 square inch section. It is rated at 30 kW. It is strong and adaptable to a wide variety of work and is said to give extreme accuracy of alignment under the heavy upsetting pressure required. The machine is water cooled throughout, and the upsetting pressure is applied by means of a powerful excentric cam designed to give the pressure in a direct line with the required "upset" and to prevent any twisting or unbalancing force from acting on the slide. The switch is foot-operated, and the heating speed is controlled by means of a three-way regulator. The application of butt welding to light engineering work, such as joining lengths of wire, welding nickel pins to steel shanks for sparking plugs, &c., will be well illustrated by the firm's No. 2 size wire welder. The machine, which is rated at 4 kW, is sensitive and efficient, and is capable of welding iron and steel—mild or high carbon—up to ⅛in. diameter, brass and similar alloys up to ⅛in. diameter, and copper up to ⅛in. diameter. Wire welded on this machine can be drawn through dies to a smaller size without the slightest trace of a weld being found. Besides the No. 2 size of wire welder, an interesting bench type machine is to be shown. It has an aluminium body, and as it weighs only 30 lb., it can easily be carried about. The electrical capacity is ½ kW, and it will weld up to ⅛in. diameter steel, 1/16in. diameter brass, and 1/32in. diameter copper. The chain welder referred to at the outset to be seen on the firm's stand, is shown in Fig. 21.

NATIONAL GAS ENGINE COMPANY.

The exhibits of the National Gas Engine Company, Ashton-under-Lyne, will be typical of this firm's principal products. They will include a 60 B.H.P. horizontal heavy oil engine which is of the cold-starting pattern using compressed air; a three-cylinder vertical 75 horse-power gas engine with recent improvements; a 7-kW horizontal oil engine and chain-driven dynamo, in which the engine has an ignition tube incorporated with the vaporiser, the tube being heated by a lamp. There will also be a 6 B.H.P. single-cylinder horizontal gas engine; a neat combination of a 2¾ brake horse-power horizontal petrol-paraffin engine driving a vertical pump through gearing, the output of the pump being 1000 gallons per hour against a head of 150ft. Another exhibit will be a small 1-kW gas engine and dynamo; and a petrol-paraffin engine and compressor with a capacity of 3½ cubic feet of free air per minute at 275 lb. per square inch, this set being specially suitable as an auxiliary for starting large oil engines. We have selected for illustration Fig. III., the 75 brake horse-power three-cylinder vertical gas engine, which is of the firm's latest design. Engines of this type are built with from one to six cylinders and yield 27 brake horse-power per cylinder at 450 revolutions per minute when using town's gas. They operate on the four-stroke principle and the reciprocating parts are all enclosed and lubricated by a forced feed system comprising a gear pump driven from the crank shaft. A feature of these engines is the keeping separate of the air and gas right up to their respective inlet valves, which are of the overhead type. The regulation of the mixture is effected by the main regulating valve controlled by a centrifugal governor. The water cooling is of the open type and ignition is effected by a high-tension magneto and sparking plugs, of which there are two in each cylinder.

The cylinders consist of outer casings into which are fitted loose liners held down against a joint at the top end by means of the top cover, the bottom end being free to expand. All liners are interchangeable. The cylinder covers are of deep section, acting as a housing for the exhaust and inlet valves. They also form the necessary ports. The covers are water cooled and provision is made for easy cleaning. The makers use a special iron for these cover castings, to avoid troubles caused by expansion and contraction. The inlet and exhaust valves are directly over the pistons and the cages of the exhaust valves are water cooled. The valves are operated by means of cams on a cam shaft which is driven from the crank shaft by means of spur gearing.

The speed of the engine is controlled by a centri-

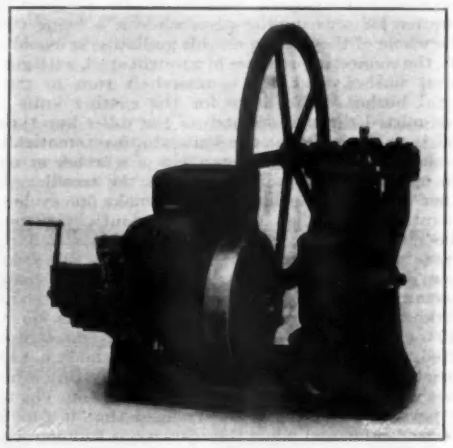


FIG. 23—2¾ H.P. ENGINE AND PUMP—NATIONAL

fugal governor mounted on the crank shaft, this governor actuates the governor valves which throttle the supply of gas and air to the cylinders. Speed fluctuations due to change of load can be corrected at will by adjusting the governor springs, and by means of this gear the normal speed of the engine can be increased 5 per cent. whilst the engine is running. The engine is fitted with a heavy fly-wheel of the disc type, and the boss of the wheel serves as a half coupling to which an electric generator or extended shaft can be directly coupled. The cooling water from the cylinders, covers and exhaust valve cages flows into open funnels at the top of the water-cooled exhaust pipe, where the temperature can be

regulated. Compressed air timing valves and inlet valves are fitted for easy starting.

The principal dimensions of this engine are:—Length, 7ft. 11½in.; height, 6ft. 6in.; and weight, 7 tons, while the heaviest piece does not exceed 1½ tons. The small pumping set illustrated by Fig. 23 is specially suitable for pumping water or oil. The engine is of the standard horizontal type, giving 2¼ to 2¾ maximum brake horse-power at 800 to 1000 revolutions per minute. It is hopper cooled and to the fly-wheel is secured a spur pinion which meshes with a large spur wheel on the pump crank shaft. The pump and engine are mounted on a common bed-plate. The pump body and ram are both of cast iron, the ram working in a cast iron gland with suitable packing. When used for pumping water the valves are of indiarubber with a light brass guard, seat and spindle, but when used for oil pumping these parts are all of brass. The connecting rod is of gun-metal and the main crank shaft bearings are ring lubricated. The pump is provided with a cast iron air vessel on the delivery outlet.

DAVEY, PAXMAN AND CO., LTD.

There will be two oil engines on the stand of Davey, Paxman and Co., Ltd., Colchester, one of which we illustrate in Fig. 24. The smaller of these engines is of the twin-cylinder type, and is capable of develop-

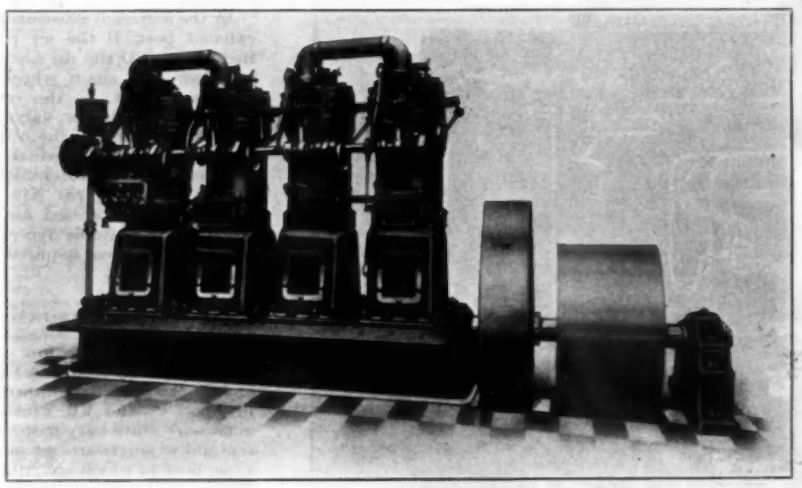


FIG. 24—160 H.P. OIL ENGINE—PAXMAN

ing from 50 to 57 horse-power, while the larger set has four cylinders, and has a normal rating of 160 horse-power, while its maximum continuous output is 184 horse-power. The general characteristics of these engines are familiar to our readers, and embody the Blackstone principle of the spring injection of the fuel oil, by means of which the atomisation of the oil is independent of the speed at which the engine is running. It is the intention of the makers to have both these engines running, with the idea of showing visitors how easily they can be started and stopped and also how "sweetly" they will run when just merely "ticking over."

Besides some separate parts of the engines just mentioned, there will be on this stand two examples of "boilers"—or perhaps it would be better to say water heaters—one of which is illustrated in Fig. VIII. This type of boiler, it is claimed, offers advantages over the ordinary cast iron type, in that it is manufactured of mild steel plates, so that the risk of fracture is avoided, and at the same time the life of the boiler is very materially increased. These boilers are built up on the multiple unit system, each section is self-contained, and there are no water joints to make—or leak—between them. The front and back sections are water cased, and the gases actually pass three times along the length of the boiler, which has a double-return flue, thereby effecting a very considerable economy in fuel. There are no tubes—only straight flat surfaces which can easily be swept right through from the doors at each end. These boilers are made in three types, namely, for central heating by means of hot water, central heating by means of low-pressure steam, and hot water supply for domestic and other purposes.

NORRIS, HENTY AND GARDNERS, LTD.

With one exception this firm's exhibits will be similar to those of last year. The exception is a new vertical four-cylinder heavy oil engine of the cold starting type, with cylinders 11in. by 13½in. in bore and stroke, an illustration of which is given in Fig. IV. It is of the two-stroke full Diesel class and is coupled to a rope-drive pulley carried on an extension of the crank shaft and supported by an outer bearing. The power developed is 152 brake horse-power at 320 revolutions per minute. The design of this engine embodies such features as ignition by the temperature of compression; symmetric and simple cylinder heads entirely water cooled; the lubrication of the main bearings and other principal parts by a circulation pressure system; the lubrication of the cylinders and big ends by "measured pressure feed;" quiet burning of the fuel; instantaneous starting; and good running at all loads without adjustment, making the engine suitable for driving electric generators, ship auxiliaries, compressor sets, or for other industrial purposes.

In these engines the compression pressure is carried up to 400 lb. per square inch, and just before the end of the stroke the charge of fuel is injected, ignited and burnt, causing the pressure to rise at full load to 580 lb. per square inch. This constant-volume combustion system has been successfully used for some years by this firm in four-stroke horizontal engines. Messrs. Gardner make a special feature of crank case scavenging, and in reply to the critics of this type of engine claim that the efficiency of their system is particularly high, the fuel consumption in an engine generating 40 or 50 brake horse-power per cylinder is as low as 0·405 lb. per brake horse-power. The air pressure in the crank chamber is 3½ lb. per square inch. Another advantage claimed for this type of engine is that the headroom required is less than usual, and the centre of gravity correspondingly lower. To withdraw a piston all that is necessary is to remove the cylinder head and take off the cap of the big end, when the piston and connecting-rod can at once be withdrawn.

The main bearings are not enclosed in the crank chambers as in a crosshead engine. They lie in the open between each crank chamber and are therefore always in sight of the attendant, while the caps and bearing shells can be readily taken from the bearings without disturbing any part of the engine structure. The crank shaft is exceptionally massive and balance weights are fitted to every crank sufficient to balance the crank pin, the crank webs and the correct proportion of the mass of the connecting-rod. Each crank is fitted with a banjo ring for lubricating the crank pin, the annulus being fed with a measured quantity of oil under pressure from one of the pumps of the multi-point lubricator. The oil is impelled by centrifugal force along an oblique passage, through the crank pin to the big end bearing.

The cylinder heads are entirely water cooled with large water spaces unbroken by intricate cores, and on the top is an annular cover plate which can be removed to expose the whole of the water space. The cover plate is secured at its outer periphery to the breech and is bored to form an expansion joint which permits of free expansion of the inner part of the breech that is exposed to the hot gases. The breech makes contact with the cylinder around the bore by a ground metal-to-metal joint. The joint between the water jackets of the breech and cylinder is made by elastic rings carried on formers around the several water ports, and each breech is provided with a vent valve which enables the engineer to test for the presence of any inadvertent air or steam locks. A relief valve is fitted to each breech as a "tell-tale," in case the pressure within the cylinder exceeds the normal working pressure at full load or overload.

The connecting-rods are bored throughout their length to form a conduit for conveying oil from the big end to the small end. The big end bearing is a bronze shell in two parts lined with anti-friction white metal and the small end bearing is of the rolling type, as illustrated in THE ENGINEER of Jan. 18th last, page 79. This consists of three simple parts, the gudgeon pin, which forms one of the rolling elements, a hardened steel key housed in the connecting-rod which forms the other rolling element, and an adjustable abutment on the upper side of the gudgeon pin, which abutment never comes into contact with the pin while the engine is at work. The gudgeon pin and the key are of steel, heat treated and hardened.

It might at first appear that there is nothing to determine the position of the rod relative to the centre of the gudgeon pin, and this is really so when the engine is at rest, but when the engine begins to turn the rod automatically adjusts itself so that line of rolling contact is always in the same place for any one assigned angular position of the rod. In other words, as soon as the engine begins to turn the rod automatically sets itself so that the key rolls to and fro through an equal distance on either side of the centre line of the rod. The relatively small angle of oscillation of the rod permits the fixing of the gudgeon pin in the piston in four different angular positions, a quarter of a turn apart, thus providing three fresh arcs of rolling contact. This is done partly because it is easy to do and partly because of the additional security that it affords in the remote contingency of a gudgeon pin developing a defect in service. As the gudgeon pin rolls on the key there would appear to be no necessity for oiling this bearing, but a film of oil is provided through a small hole in the key.

The air compressor for starting purposes is built in with the engine and is driven by a crank and connecting-rod from the main crank shaft. It is of the two-stage type with pistons tandem fashion. The cylinders are water cooled and are fitted with safety valves at each stage and a cut-out valve for use when the air bottles are filled. The starting valves, one on each cylinder, are automatically operated by the cam shaft. The movement of a lever puts all the valves simultaneously into or out of action.

Each cylinder is served by a separate pump, which accurately measures the charge of fuel oil according to the load on the engine and forces it under pressure to the fuel sprayer, which atomises it into the combustion chamber. The amount of the fuel charge per stroke of the pump or engine is automatically controlled by the governor. Safety valves are fitted to each pump. The fuel sprayer is simple and contains a spring-loaded valve through which the fuel passes on its way to the sprayer nozzle, and each sprayer is fitted with a strainer which is supplementary to the main strainer fixed in circuit with the fuel distribution pipe.

CROSSLEY BROTHERS.

Two new and extremely interesting examples of heavy oil engines will be exhibited by Crossley Bros., Ltd., Manchester. They illustrate very clearly the present-day tendency on the part of builders to employ

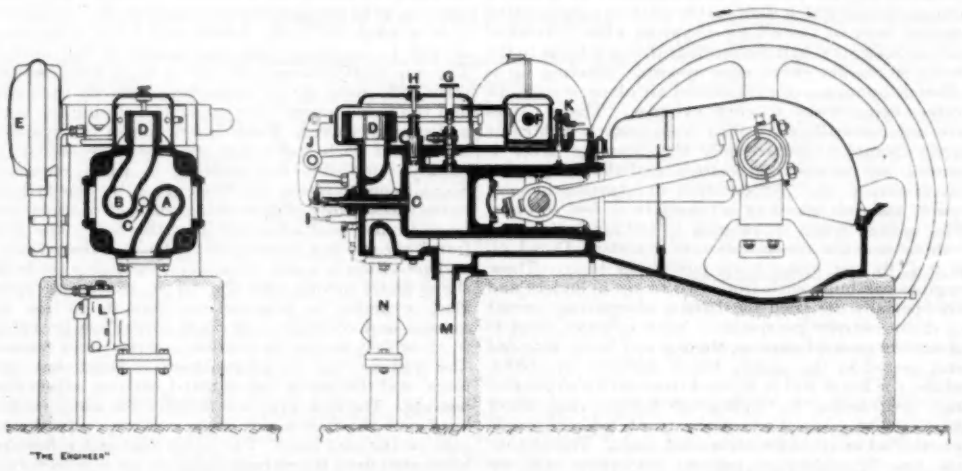


FIG. 26—SECTIONAL VIEWS. TWIN-CYLINDER HEAVY OIL ENGINE—CROSSLEY

the multi-cylinder type, which gives a more even turning moment than is obtained from engines with one large cylinder, an abnormally large fly-wheel and heavy moving parts. Other advantages possessed by the multi-cylinder engine are the avoidance of costly foundations, the minimisation of heat stresses and increased flexibility as compared with engines of the single-cylinder class. Considerable originality

will be noticeable in the design of both of these new engines. The vertical engine is enclosed, with no moving parts exposed, and all the valve mechanism is contained in a shallow rectangular casting on the top of the main body, the moving parts being automatically lubricated by means of pressure from a central source. The bore and stroke of the cylinders are 8½in. and 12in. respectively, and the normal rating is 110 brake horse-power at 500 revolutions per minute. At the Exhibition the engine will be shown coupled directly to a Crompton 72-kW, 440-volt direct-current dynamo. A general view of this engine is given in Fig. 26. It is of the compressorless type. Easy access to the interior is afforded by inspection doors on both sides, while large cover plates are provided on the top, these being semi-hinged so that they can be opened immediately by hand or detached without releasing a single bolt. By raising these plates the fuel sprayers, valve levers, cam shaft and operating gear are exposed to view. The engine can be operated with these cover plates either closed or removed. As will be seen from the sectional view, the inlet and exhaust valves are situated in the cylinder heads and are operated directly from levers without the introduction of push rods on the shaft actuating the valve levers. The cam shaft is carried in substantial journals and is lubricated under pressure. The avoidance of push rods and knuckle joints gives a very silent operation of the valve mechanism. A silent roller chain is used to drive the cam shaft, the chain being entirely enclosed and continuously lubricated. Stretch of the chain is compensated for by means of an ingenious tensioning device. A feature of this device is that it does not disturb the valve timings. The engine frame is of the box girder type. The base plate, which carries the crank shaft and bearings, is stiffened by ribs inside while its underside is machined to allow the engine to be bolted to a combination bed-plate if required. The crank shaft is of unusually large proportions, and the webs are cut out of the solid. The bearings for the crank shaft journals are adjustable and the connecting-rod ends are of ample proportions. The fuel pumps are grouped together in one unit at one end of the engine and there is a separate pump for each cylinder. The pump body is machined out of the solid and contains the hardened steel plungers which work in detachable plunger guides. The amount of fuel oil injected into the cylinder is positively and accurately measured according to the load. This is effected by the governor, which varies the time when each pump control valve is opened. The actual governing effect takes place at the moment when the fuel is being burned, so that it is very sensitive and accurate under all conditions of load. The governor is of the centrifugal type and is mounted directly on the crank shaft. For synchronising purposes in the case of alternators to be driven in parallel, hand regulating or speeder gear is provided to vary the speed of the engine within certain limits. For lubrication purposes the oil pressure is maintained by a simple plunger pump which delivers the oil from a sump in the engine base to the oil pipe system after filtration. After passing through the bearings the oil returns to the sump on the dry crank case system. Starting up is effected by means of compressed air alone, starter air valves being fitted to each cylinder. These valves are automatically controlled from cams which come into operation immediately the starting lever is moved into its starting position, and the compressed air is turned on. Acceleration at starting is very quick and full speed is attained in a few seconds. The normal speed of running is 450 revolutions per minute and the consumption of standard Diesel oil is 0·43 lb. per brake horse-power per hour. These engines are built with from two to six cylinders and are specially designed for driving alternating-current or direct-current generators. Each cylinder consists of a plain parallel casting, the top end being spigoted and nested in the engine frame without any bolts, whilst the lower end is allowed freedom for expansion and contraction by sliding in rubber ring water joints. The pistons are of the trunk type of ample length and are fitted with special rings. The pistons are heavily ribbed to prevent distortion and are accurately ground to fit. The gudgeon pins are secured to the pistons by means of keys to prevent turning, and the centres of the pins are bored out to reduce the weight to a minimum. The fuel sprayer is of the differential spring-loaded kind, easily detachable for cleaning. For cooling purposes inlet and outlet water connections are fitted and the system of cooling is either by gravity feed or by pump circulation.

The other heavy oil engine to be shown by Crossleys is also new. A general view of it is given in Fig. II. and sectional views in Fig. 25, from which a striking departure from conventional design is apparent. This engine has twin cylinders, 8in. bore by 12in. stroke, and the normal output is 44 brake horse-power at 375 revolutions per minute. It is of the enclosed airless injection type with a very complete system of automatic lubrication. Hitherto Crossleys have been mainly identified with the open type of horizontal engine, and this new departure has been introduced to meet the demand for the enclosed type.

There are numerous novel features incorporated in the design, one of the most noteworthy being the abolition of the side shaft and gear wheels. Instead, a cam shaft arranged across the top of the cylinders is driven by a silent roller chain which is enclosed in a casing and runs in an oil bath. The chain tension, as in the case of the vertical engine, is adjustable by means of jockey wheels, which are arranged so as not to interfere with the timing of the valves. The cam shaft and cams revolve in an oil bath and the push rods make direct connection between the cams and the valve levers for opening and closing the inlet and exhaust valves. These levers are in the cylinder heads and each valve has its own cage, which is readily removable for grinding-in when required. Special consideration has been given by the makers to the accessibility of all working parts, all of which can be examined and adjusted from the top. The bed frame of each unit extends to the back of the cylinder and provision is made to prevent the burnt oil from the cylinder mixing with the oil in the crank case. Each cylinder is arranged so that it is free to expand and contract, and large covers are provided to allow easy access for cleaning out the water spaces. The pistons are of great length. Each has six rings, and the piston pin is fitted with an adjustable bearing. The fuel sprayer is fitted in the water-cooled head and the fuel pump is operated by a hardened cam on the cam shaft. The pump cam and roller are lubricated from the oil bath in which the cams revolve.

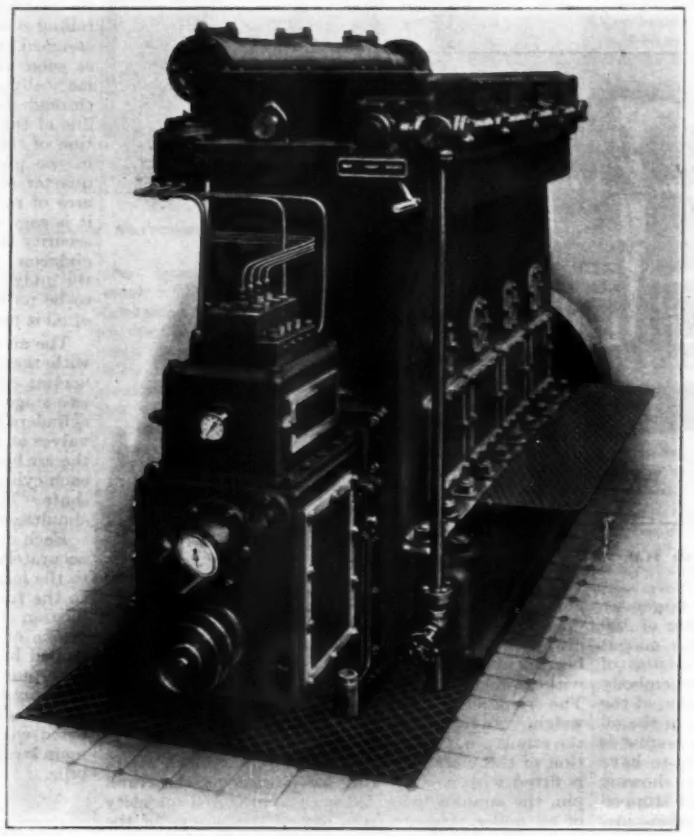


FIG. 26—FOUR-CYLINDER COMPRESSORLESS OIL ENGINE CROSSLEY

These engines have been designed to work with a speed variation of about 3 per cent. above or below the normal speed, from full to no load. The governing is effected by means of a system varying the time at which the control on each pump is opened. In this way any oil not required is returned to the suction side of the system. Each control valve is opened by a lever, the fulcrum of which is under the control of the governor and varies the time when the valve is opened, the power of the impulse being graduated according to the speed and load on the engine. An important feature of this gear is that the fuel pump, which has a constant length of stroke, always begins and delivers the fuel oil through the sprayer at precisely the same time and at the same speed and the spraying is equally efficient at all loads. Another good feature of this gear is that it is always in full view. The power of the engine and the regularity with which it is working is indicated by noting the position of a quadrant seen in the general view.

Oil bath lubrication is employed for the following parts:—The cam shaft, the chain driving the cam shafts, the governor and its mechanism, and the main bearings. The only parts which require forced feed lubricators are the big end bearing and the piston. The engine is not restricted to the use of Diesel oil as fuel, but will operate on all grades of non-asphaltic fuel oils.

In the sectional illustration A is the exhaust port, B the air port, C the fuel sprayer, D the air silencer, E the governor and chain wheel guard, F the cam shaft, G the compression valve, H the starter valve, J one of the valve levers, K the oil tube and non-return valve, L the fuel oil strainer and heater, M the water inlet pipe, and N the exhaust pipe. The engine is started by compressed air, which is stored in a suitable receiver and is self-charged when required from the engine cylinders.

G. D. PETERS AND CO., LTD.

The Plastic Arc welding equipments which are to be shown by G. D. Peters and Co., Ltd., of Slough, are represented in Figs. V. and VI., which illustrate a two-arc stationary motor generator set and a single-arc set of a portable type, both of which are equipped with Wilson automatic control panels. By means of these control panels, the current can be so regulated as to be so steady and uniform that the variation is never more than 5 per cent. The effect of this constancy of supply is that the heat in the weld is localised and it is possible to weld large iron castings without preheating, which is obviously a great advantage, since heavy machines can be repaired without the necessity of being dismantled.

Another important feature of the Wilson plant is the low current intensity employed, which only amounts to 18 volts at the actual arc, and obviates the necessity of using expensive fluxed or slag-covered electrodes. The economy effect is two-fold, since the cost of "Colour-Tipt welding" metals is materially less than that of the slag-covered variety, and the costly process of chipping is entirely eliminated, the slight oxidisation which occurs being easily removable with a wire brush.

The two-operator stationary welding plant comprises a suitable motor direct-coupled through a flexible coupling to an open bracket-type level-compounded generator, having a capacity of 300 ampères at 37½ to 45 volts, the variation in voltage being controlled by shunt field regulation. The motor generator set, complete with motor starter, is mounted upon a base plate with two automatic current control panels. The single-arc portable motor generator set consists of a motor directly coupled to an open bracket-type welding generator, having a capacity of 150 ampères at 37½ to 45 volts, a shunt field regulator being used to control the voltage supplied. This panel is mounted together with an automatic current control panel, motor starter, and shunt field regulator, on a substantial channel base plate. This set will be shown in operation, and the makers will be glad to demonstrate any experimental welding jobs which may be offered to them on the stand. There will also be a variety of welding metals and a demonstration of the rust-removing qualities of Graphol on this stand.